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ABSTRACT

Time, space, money, and educational opportunities were the four major factors considered in upgrading the individual teaching labs at the University of Florida. The program incorporates the use of single processor microcomputers to teach a variety of courses. Software developed for a course on cognition and perception will set up a ready to run experiment, present the stimuli, collect the data responses, and do a number of transformations of the raw data. The essence of the approach is the use of the computer as the students' personal lab assistant--the students can serve either as the subject or the experimenter. Another approach uses the computer and videotape in combination to solve problems. The costs of setting up a computer-based undergraduate teaching lab are also briefly discussed, as well as the availability of instructional courseware. (JEG)

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A DEPARTMENT-WIDE UNDERGRADUATE TEACHING LABORATORY USING MICROCOMPUTERS

by

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A DEPARTMENT-WIDE UNDERGRADUATE TEACHING LABORATORY USING MICROCOMPUTERS

C. Michael Levy
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I am going to talk this morning about the factors that went into our decision at the University of Florida to upgrade individual teaching labs and to create a shared lab to meet diverse departmental interests. I will focus as much on why we did what we did as on how we have done what we have done. Our considerations focussed on four major factors: time, space, money and educational opportunities.

Let's consider time. We have slightly more than 550 majors and only about two years access to them. During that period, we have an obligation to provide a broad base in the fundamentals of the major areas of psychology, in experimental design, and statistics. Therefore, we have a responsiblity to prepare them well for their distal educational objectives which includes postbaccalaureate studies for more than 80% of our students. One critical aspect of this training involved, in our judgment, a reasonable amount of direct experience with the laboratory aspects of psychology.

If the laboratories offered rich and exciting learning experiences, we expected that the most serious students would take several laboratory courses as well as conduct independent research projects and senior honors research. We anticipatated that students should be able to do a far better job on these advanced research projects after they acquired the relevant skills and self-confidence in their formal, structured laboratory courses. We also felt that even the terminal BA student in psychology needed some laboratory experience to develop a full appreciation for our discipline. Therefore, we instituted several years ago a departmental requirement specifying that all majors complete at least one laboratory course in psychology.

Then, there was the problem of space. Given the anticipated onslaught of students, where were we to put them? There was no way that we could manage to run the laboratory courses in our research laboratories. And wholesale renovation of equally valuable classrooms was not a viable option. We could manage to free up one room for departmental laboratory courses in eight content areas, but not eight rooms.

There were also financial considerations. Buying enough student equipment represented a sizeable one-time cost. A small shopping list would include tachistoscopes and reaction timing devices for cognitive psychology, Skinner boxes and cumulative recorders for the experimental analysis of behavior group, Crutchfield stations for social psychology, stereotaxic instruments and microscopes for psychobiology, and other hardware for sensory and perceptual psychology, developmental, and personality. But our experience had been that the real difficulty with this equipment was not the up front expenditure, the long-term maintenance and hidden costs. Some hands-on hardware implied other costs--e.g., the Skinner boxes and stereotaxic instruments implied recurring expenses to support laboratory animals.

Finally, providing a virgin researcher with reasonable laboratory expertise in a 10-week quarter is extremely labor-intensive. We reasoned, however, that the costly, but close, supervision students could receive in hands-on laboratories could be achieved if a significant amount of the supervision could be accomplished by a computer system. If we were clever, the computer could do a great deal more.

For example, Dana Main and Robert Stout at Michigan had devised the EXPER SIM concept. Their large FORTRAN system went under the acronym, MESS (for Michigan Experimental Simulation System). It was particularly well-suited for batch operation on a large University computer. Robert Thurmond and Art Cromer at the University of Louisville had written a basic version, called LESS, which we could use on a dedicated mini-computer because it was comparatively small. Furthermore, LESS had an executive-level program to permit nonprogrammers to easily add new modules to the system.

MESS and LESS modelled experiments in the sense that they could generate quite realisitc raw data for a particular experimental paradigm. They relieved the students from such time-consuming aspects of research as recruiting of subjects, stimulus preparation, repetitively administrating procedures, as well as scoring and tabulating raw data. In an elegant way, they directed the focus of students to possibly the most important aspects of research -- that is, thinking about an experimental design and thinking about the meaning of a set of data. Students could focus, if you will, on the cognitive aspects of laboratory research and could ignore the psychomotor components.

There was one significant drawback to LESS, however: it didn't always work. After two years of collaboration with the Louisville group, it became clear that support of LESS was not high on their priority list. So we completely rewrote the LESS system. Because it is very much smaller, we have nicknamed it MUCHLESS. It requires only about 3.5 K words for any program, making it appropriate for even a time-sharing microcomputer.

There is a secondary problem common to MESS and LESS: Even though a sizeable number of institutions have adopted EXPER SIM, other than the presentations to be made today, model writing appears appears to have been stopped about 1975 or 1976. Perhaps there are hundreds of models out there in the world. If so, the model builders have been very shy about advertising their availability. So one of our major efforts has been to develop a substantial set of new EXPER SIM models. We have 10 new models completed or nearly so, and I will describe some of them shortly.

A second way to get around the problems of the traditional lab is use the computer to model experiments in a very different sense than they are modelled by EXPER SIM. For example, for many years psychologists have used dedicated computers to control and monitor their research environment. Why not do the same in an undergraduate lab? Indeed, this has been done at a number of institutions for some time, but the dedicated computer's major role is to monitor and control equipment that could be serviced as readily by other devices such as timers, relays, and digital recorders.

Why not go one step further, and program the computer to model all of the equipment in the laboratory? A very basic or "dumb" videoterminal, for example, sending characters at 9600 baud, theoretically can display them at a rate of 960 per second, or nearly one every ms. Allowing for less than optimal transmission rates resulting from the action of the software, 960 character/second will not ordinarily be achieveable, but an effective rate of 500 per second is usually possible. This rate is equivalent to a 20 ms tachistoscopic display. Slowing the rate allows the terminal to model a memory drum or slide projector.

A not-quite-so-dumb terminal will allow a great many more options. Control over screen blanking permits an entire screen full of characters to be written out, and turned on and off as an entity, simulating even better the action of a tachistoscope. A built-in speaker which can be accessed by the software will permit a limited number of psychophysical experiments to be mounted as well as to

deliver feedback or simuli in the auditory domain. With modest or full graphics or a programmable character generator, the sky's the limit.

The upshot of all of this is that for a quite modest, one-time investment, a department can outfit a laboratory to serve the basic needs of a large number of distinctly different undergraduate laboratory courses. By "modest", I mean that for $6000-7000 you can get on-line with one stand-alone microcomputer complete with all the goodies needed to make it functional, including a lot of memory, a floppy disc, a videoterminal, high level software, and an operating system. If the operating system allows time-sharing, and real-time control is not always required, several additional student stations may be added for under $1000 each.

We built our first laboratory for our Cognition and Perception course around a PDP II. When we began, only Bewley's package of Cognitive Psychology programs was available and it was not quite what we wanted. So we started from scratch and designed our own courseware. Several thousand person-hours later, a thoroughly tested and documented course was accepted for distribution by CONDUIT. The tactics we used for this course are similar to those used in Jan Keenan's Learning and Memory course, which she will describe later. The essence of our approach is the use of the computer as the student's personal lab assistant whereby the machine will set up a ready-to-run experiment, present the stimuli, collect the responses, and do a number of basic transformations of the raw data. In this mode, the student can sit at the terminal and serve as the subject, or find other warm bodies and participate as the experimenter.

A substantial component of our sensation and perception, cognition, learning, memory, and information processing courses employ the computer in this fashion. Students in the sensation and perception course, for example, can presently choose among 12 combinations of illusions and classical psychophysical procedures to study the different constant errors and jnd's which result therefrom, and then advance to studies using contemporary psychophysical methods. They can then interact with a new EXPER SIM model on dark adaptation, exploring some of the 5600 possible experimental manipulations this model permits, or may work on an equally complex model based upon the McCollough effect.

In social psychology, we thought it might be fun as well as instructive to create a program which would employ the computer as an agent to change the student's attitude

towards a given topic. After some reflection, we abandoned this because once the ethical problems were resolved, the reasonable issues upon which such an attitude change model could be built seemed to range from the trivial to the superficial. We did considerable work on a model which turned the problem around 180 degrees -- where the student would try to change the computer's attitude about a topic. The student would adopt a theoretical portion and, to succeed in changing the computers' attitude would have to select theoretically appropriate methods and techniques. Testing of the prototype revealed that the model was tortuous. It was hardly fun or particularly interesting. Work has been redirected towards the development of an EXPER SIM model to convey the equivalent concepts. Models for social psychology in population and environemt, in persuasion, and aggression are nearing completion at this time.

EXPER SIM models are also being devised on habituation and dishabituation for developmental psychology, and on neurochemical factors involved in ingestion as well as the action of neurotransmitters for biopsychology. We are especially happy with two new EXPER SIM models for comparative. One, dealing with behavior genetics, is most impressive to students, for they can within about an hour perform the breedings which could be accomplished in the real world in about 10 years. The other is important because it allows students to make comparisons both between and within-subjects. While the framework on which this model is hung is merely the copulatory behavior of roderts, it is extremely popular. Our students may be unusually voyeuristic.

Our operant laboratories have followed the cognitive laboratories in having the computer model equipment and paradigms directly as opposed to the more indirect route of EXPER SIM. In the shaping program, for example, the computer is the Skinner box, the organism, and the reinforcement. It generates the organism's behavior, leaves a visual trace of it on the screen, and insures that the behavior is reinforcement-dependent. In other models, the student becomes the experimental subject. In one of these, the development of superstitious behavior during acquisition and response rigidity during experimental extinction is demonstrated with the students, of course, exhibiting the superstitiousness and rigidity. Another requires the student to press the space bar in order to earn points, and places the student under different schedules of reinforcement. The student's job is to try to verbalize his or her schedule, which as you might imagine, is extremely difficult when the schedule is a multiple FI 20 sec, FR 60.

There are other uses of the microcomputers which I have grouped together under the broad heading of "hybrid". Included here is a model in personality which requires both the use of the computer and a videotape which portrays a card game played by four people. The student used the computer to generate an individualized measuring instrument from a menu of 54 general and specific verbal and nonverbal behaviors and then uses this instrument to describe the behavior of one of four specified individuals observed in the videotape. Subsequently, the student enters his or her responses into the computer which compares them to known values. In this manner, students come face to face with problems of interjudge reliability. If the students are unlucky enough to select a set of behaviors which were never displayed on the tape, then they quickly come up against the matter of the sensitivity of their measuring instrument.

Another hybrid use of the computer and a videotape is exemplified by a biopsychology model dealing with the effects of hypothalamic lesions on ingestion. I have already mentioned the EXPER SIM component of this model. But before students begins work on this model, they view a videotape which portrays animations of the activity at the neural sites when various chemically or mechanically induced lesions are made. The animations were created with comparative ease on the computer and were recorded directly from it's composite video output. The decision to tape the animations (rather than to permit each student to view them directly on the computer) was based on the fact that the the student is completely passive during this component of the model. We wanted to be careful to convey to students that while they were using a computer, activity rather than passivity was expected.

What does the approach I have described buy from the student's point of view? It buys the student opportunities to learn more about a content area by allowing explorations in greater depth and breadth than is permitted in a conventional, hands-on laboratory. Any well-planned computer-based lab can achieve these goals simply by relieving the student and lab assistant of the time-consuming chores of equipment setup and calibration, stimulus preparation, hand scoring and tabulation of data, and so on. But a microcomputer-based lab has several additional virtues. The same dollars invested in a microcomputer lab and, say, a minicomputer lab buys more microcomputers. The redundancy of equipment means that one hardware failure will not shut down the entire lab as it could if everything were tied to one powerful machine. Further, it should be obvious that the cost advantage of

microcomputers means that anyone can have a lab up and running far sooner.

Now what will a microcomputer lab cost today? As I indicated earlier, a very good, one-station stand-alone system can be purchased for about $7000. The so-called personal computers, cost even less, but will require some engineering expertise if you wish them to have the versatility of the machines that cost more to begin with. Some of the initial costs cover the operating system, which should have to be purchased only once.

If your budget is in the neighborhood of $20,000 you could set up 3 stand-alone systems and 2 additional videoteminals, for a total of 5 student work stations. If your budget were twice that then 12 students could work simultaneously. Based on a 40 hour lab week, then, you will have 480 student terminal hours available.

We have found that most students can accomplish in one hour per week on the computer about what they could in 2 or 3 hours of hands-on work in a more traditional lab. Therefore, 12 stations should be adequate to serve the needs of as many as 24 sections of lab courses with 20 students each.

As the cost of hardware has come down, more and more of our colleagues seem to be going this route in teaching their undergraduates. So we anticipate a great expansion in the amount of instructional courseware available. In the meantime, if you cannot find immediately useable programs from the usual sources (your mainframe's user society, CONDUIT, ERIC, or the California ABC network), then you might turn again to NSF. Their LOCI program is specifically designed to aid one or more instructors who wish to upgrade the curriculum of one or more courses, and has funded a substantial number of proposals aimed at the development of computer-based instructional materials.

So getting an on-line laboratory on-line is not incredibly difficult either from the perspective of equipment acquisition or of curriculum development. The main problem we have found is that many instructors become so enamored of these systems that they often expect them to do either the impossible or the inappropriate. It is really not feasible to take one of these single-processor microcomputers and make it behave as if it had multiple processors -- as for example, running two different programs, each requiring the collection of reaction time. It is an inappropriate use of such powerful equipment to relieve it of all of its computing capabilities and have it model, for example, a book or a handout or a videotape.

Building a computer-based undergraduate teaching lab is serious business, not to be taken lightly. We recognize this far more so than when we began, but in view of the smiles of the accountability moguls and the enthusiasm of our students, we are very glad that we took the leap.